

## REMARKS

Before proceeding with the election of species the Applicants wish to comment of the amendments which are directed toward the accelerators disclosed and claimed, specifically claims 5, 9, 14 and 19. First, the term "sulfonamides" was an inadvertent typographical error for "sulfenamides". The latter are accelerators, while the former are not. Support for the sulfenamides, correctly appears in the specification at pages 1, lines 27-28, "CBS (*N*-cyclohexyl-2-benzothiazole sulfenamide)"; and again at page 13, line 13 and page 14, line 23. A corresponding amendment to the specification has been made at page 13, line 7.

Next, the Applicant's have inserted the term "thiazoles" into dependent claims 5, 9, 14, and 19. Thiazoles include MBTS, as well as CBS, a sulfenamide, two accelerators utilized and exemplified by the Applicants (specification, page 18, lines 9-11; page 19, Table IV; pages 20-21, Table V; pages 24 and 26, Table VI; pages 27 and 29 Table VII; page 33, Table VIII and page 36, Table IX). While MBTS is a useful and exemplified accelerator, its family was inadvertently not included as a species of accelerator in the claims.

The term "thiazole" is recognized in the art and to support that contention, the Applicants have included as Exhibit A, excerpts from the "Compounders Pocket Book", published by Flexsys, as a reference to the rubber industry for various chemicals they supply, including accelerators. Among accelerators are: "thiazole based", "thiurams", recited in the claims and "dithiocarbamates", also recited in the claims. At pages 1, 3, 5 and 11 are listed MBTS and related thiazoles and at pages 7, 9, 13 and 15 are listed CBS and related sulfenamides. Inasmuch as "thiazole based" includes the sulfenamides, the latter term can be removed from the claims by an appropriate amendment. The Applicants have also included as Exhibit B, excerpts from the "Rubber Chemicals Equivalents List", (5 pages) published by Monsanto, the predecessor of Flexsys. The Monsanto reference also listed various chemicals supplied to the rubber industry from several

manufacturers. The included pages present several exemplary thiazoles, under that heading.

Finally, the amendment at page 9, is merely to complete the identification of the long chain elastomers of the present invention, so that it now comports with corresponding identifications throughout the application.

Focusing now on the restriction requirement, in support of the request that a single disclosed species be elected, the Examiner has provided the following: a) Applicants are required to elect a single species of rubber by electing a single rubber from one of those at lines 5-9 of claim 1; b) applicants are also required to elect a single accelerator by electing one of the accelerators in instant claim 5; c) applicants are also required to elect a single "difunctional cross-linking agent" by selecting a single choice for R and for R' and for R'' and for X from one of those set out at lines 11-21 of claim 1; and d) the applicants are also required to elect a single choice for m and n.

Each of the requests are addressed separately as follows.

a) The Applicants traverse the request that a single species of rubber be elected. All of the rubber materials, which include natural and synthetic rubbers are unsaturated polymers which are sulfur vulcanizable. The particular rubber vulcanized (cross-linked) is not significant to the claimed invention, which is based on the use of Applicants' difunctional cross-linking agent. For purposes of examination, the Applicants elect styrene-butadiene rubber, with traverse.

b) The Applicants election of a single accelerator from claim 5 is the term "thiazole based materials" according to the amendment discussed hereinabove. It has been explained that the term embraces two exemplified accelerators, MBTS and CBS. If further restriction is required, the Applicants elect, with traverse, MBTS (2-mercaptobenzothiazyl disulfide).

c) The Applicants election of a single difunctional cross-linking agent includes the following choices: where R is R''XR''; where R' is the branched and linear C1 to C10 alkyls; where R'' is the branched and linear C2 to C10 alkylenes and, where X is O, oxygen.

d) The Applicants election of a single choice for the subscript m is where m is 1. The Applicants traverse the request for an election of a value for the subscript n. The Applicants note that the formulation for a dimercaptan cross-linking agent having the general formula

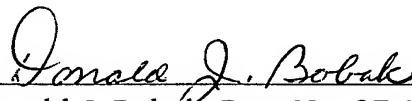
HSRSH

(specification page 10), includes the Thiokol™ family of prepolymers, which vary from about 1000 g/mol to about 8000 g/mol. During cross-linking, the prepolymers break down into a number of different size units and accordingly, it is not readily possible to pick a single integer value. Rather, multiple values for n, between 1 and 100, apply.

The Applicants have reviewed the claims and contend that all claims read on the foregoing elections. No claims are cancelled at this time and none have been added. There are no changes to the inventorship resulting from the elections made.

In the event the examiner wishes to discuss any of the foregoing in greater detail, the undersigned attorney would welcome a telephone call.

Respectfully submitted,



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Attorney for Applicants

Dated: January 23, 2003

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Inventors: Hergenrother et al.  
Attorney Ref.: P01038US1A (FIR.P292)

MARKED UP VERSION

In the Specification:

The paragraph beginning on page 9, line 22, has been amended as follows:

OK  
OK  
The long chain elastomers of the present invention having the structure  $Y_m(SRS)_nY_m$  where Y is selected from the group consisting of H, SR' and SiR'<sub>3</sub>; where R is selected from the group consisting of branched and linear C2 to C20 alkylene, C6 to C20 arylene, C7 to C20 alkyarylene and C4 to C20 cycloalkylene groups and R''XR''; where R' is selected from the group consisting of branched and linear C1 to C10 alkyl, C6 to C10 aryl, C7 to C10 alkyaryl and C4 to C10 cycloalkyl groups; where R'' is selected from the group consisting of branched and linear C2 to C10 alkylene, C6 to C10 arylene, C7 to C10 alkyarylene and C4 to C10 cycloalkylene groups and R'' can be the same or different; where X is selected from the group consisting of O, S, NH, NR' and mixtures thereof; where  $m$  is 0 or 1 and  $n$  is 1 to about 100.

The paragraph beginning on page 13, line 7, has been amended as follows:

Representative of conventional accelerators are thiazoles, amines, guanidines, thioureas, thiols, thiurams, [sulfonamides] sulfenamides, dithiocarbomates and xanthates which are typically added in amounts of from about 0.2 to about 10 phr, with a range of from about 2 phr to about 5 phr being preferred. Representative of sulfur vulcanizing agents include elements sulfur (free sulfur) or sulfur donating vulcanizing agents, for example, an amine disulfide, polymeric polysulfide or sulfur olefin adducts. Useful examples include CBS accelerator (*N*-cyclohexyl-2-benzothiazole sulfenamide), DPG accelerator (diphenyl guanidine) and, for examples in the invention, MBTS accelerator (benzothiazyl

disulfide). The thiazoles include CBS, also a sulfenamide, and MBTS, while DPG is an exemplary guanidine.

The paragraph beginning on page 14, line 20, has been amended as follows:

68 The same basic rubber formulation is used throughout the examples, for both the control compounds and the compounds illustrating the invention, with the exception of the cure package or cure system, where the cure package or system may include sulfur, CBS accelerator (*N*-cyclohexyl-2-benzothiazole sulfenamide), DPG accelerator (diphenyl guanidine) and, for examples in the invention, MBTS accelerator [(2-mercaptobenzothiazylsulfide)](2-mercaptobenzothiazyl disulfide) and Thiokol™ LP31. Table I lists the rubber formulation used throughout the examples.

In the Claims:

5. (Amended) A long chain crosslinked elastomeric composition of matter, as set forth in claim 1, wherein said accelerators are selected from the group consisting of thiazoles, amines, guanidines, thioureas, thiols, thiurams, [sulfonamides] sulfenamides, dithiocarbamates and xanthates.
9. (Amended) A method, as set forth in claim 6, wherein said accelerators are selected from the group consisting of thiazoles, amines, guanidines, thioureas, thiols, thiurams, [sulfonamides] sulfenamides, dithiocarbamates and xanthates.
14. (Amended) A rubber article, as set forth in claim 11, wherein said accelerators are selected from the group consisting of thiazoles, amines, guanidines, thioureas, thiols, thiurams, [sulfonamides] sulfenamides, dithiocarbamates and xanthates.

19. (Amended) A pneumatic tire, as set forth in claim 16, wherein said accelerators are selected from the group consisting of thiazoles, amines, guanidines, thioureas, thiols, thiurams, [sulfonamides] sulfenamides, dithiocarbamates and xanthates.

W/LH

COMPOUNDERS  
POCKET  
BOOK

CHEMICALS  
FOR THE RUBBER INDUSTRY

FLEXSYS

Exhibit A

### **Flexsys & The Rubber Industry**

Flexsys is the world's leading producer of chemicals for the rubber processing and related industries. The company was formed in 1995 as a joint venture between Monsanto and Alzo Nobel, combining the rubber chemicals business of both companies. In 1997, Monsanto spun off its chemicals operations, including its investment in Flexsys, to the newly formed company, Solvita Inc. Flexsys inherited from the two parents over 100 years of combined experience in serving the rubber and tire industries. The company possesses the state-of-the-art technology and is supported by world class manufacturing spread over Americas, Europe and Asia-Pacific to supply a broad range of high quality products. Value-added technical services are provided by experienced compounders and technicians at the Deventer and Akron R&D stations, and technical centers at Singapore, Ichikawa Japan, and Sao Paulo Brazil. Flexsys' headquarters and European/Africa regional office are located just outside Brussels, Belgium; its regional office for Americas is located at Akron, Ohio, and its Asia-Pacific regional headquarters in Singapore.

#### **NOTICE:**

The information contained in this report is, to our best knowledge, true and accurate. However, before adopting any of these recommendations or suggestions, we urge you to determine for yourself whether these procedures should be adopted for your use. Nothing contained herein is to be construed as a recommendation to use or sell any product in conflict with any patent. Flexsys makes no representation or warranty of any kind, express or implied as to merchantability, fitness for particular purpose, or otherwise, with respect to the products referred to, whether used alone or in combination with any other material. Flexsys makes no guarantee of satisfactory results from reliance upon information, statements or recommendations contained herein and disclaims all liability for any resulting loss or damage. The data in tables and graphs are based on samples tested in laboratories and are not guaranteed for all samples. The experimental responses are for information sensitive and are not guaranteed for all applications. In all cases, confirmatory tests should be run in a user's compound.

## Table of Content

Section 1 Product Information  
Information subject to change. For current product information refer to <http://www.itesps.com>

	Page
<b>Accelerators</b>	1
<b>1. Thiazole Based</b>	2
Pekocil®MBI	2
Pekocil®MBIS	3
Pekocil®ZV/BI	7
Santocure®ZV/BI	9
Santocure®CBS	11
Santocure®DCBS	13
Santocure®MBS	15
Santocure®TBS	15
Santocure®TBSI	15
<b>2. Thiurams</b>	17
Pekocil®DPT	19
Pekocil®IBZD	21
Pekocil®ETD	23
Pekocil®TMD	25
Pekocil®TMM	25
<b>3. Dithiocarbamates</b>	27
Pekocil®NDBC	29
Pekocil®SSEC	30
Pekocil®SDBC	31
Pekocil®SDEC	32
Pekocil®SDMC	33
Pekocil®TDEC	35
Pekocil®ZBEC	37
Pekocil®ZBEC	39
Pekocil®ZDEC	41
Pekocil®ZDMC	41
<b>4. Miscellaneous</b>	43
Pekocil®DPS	45
Vocor®ZBP	45
<b>Antidegradants</b>	
<b>1. Antidegradants/Antiflex Agents</b>	
GHex®COI	47
Santolex®GPD	49
Santolex®77PD	51
Santolex®IPPO	53
<b>2. Antidegradant Blends</b>	
Santolex®155PD	55
Santolex®157PD	57
Santolex®150PD	59
<b>3. Antioxidants-Staining</b>	
Pector®TMO	61
Pemmar®ODPA	63

**4. Antioxidants-Non-Staining**  
Montocler®SPH  
Santowax®BMC  
Santowax®TAHQ  
Santowax®BBMC

**Insoluble Sulfur**  
Cystex®OT  
Cystex®HS OT  
Cystex®OT AS  
Cystex®HD OT 20  
Cystex®60 OT 10

**Specialties**  
Durink®HS  
Perkolink®300  
Santogard®PVI  
Santowax®D  
Santowax®DX  
Santowax®H  
Santowax®W  
Sulfocor®DDM  
Vulcostad®LV  
Masterbatches

## Section II

General Handling Procedures for Chemicals

## Section III Compounding Reviews

Vulcanization Overview  
Efficient and Semi-Efficient Vulcanization Systems  
Non-nitrosamine cure system  
Santogard®PVI Pre-vulcanization Inhibitor  
Antidegradant Overview  
Cystex insoluble sulfur in compounding  
Thermal and Thermal/Oxidative Resistance Compounding  
Daily manufacturing problems  
Problem solving with fish bone chart

## Section IV Useful Information

ISO Information and Certification  
Comparative Cure Chart  
Conversion Factors  
Starting Point Formulations  
Water Capacities, Bombury and Mill  
Properties of Rubber  
Elimination of Shore A Durometer  
Carbon Black Properties  
Specific Gravity of a Compound  
Temperature Conversion  
Temperature equivalents of Saturated Steam at sea level  
Stress (Tensile) Conversion  
Adhesion (Tear strength)  
Test sieves, Nominal Apertures

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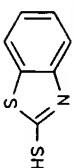
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## PERKACIT MBT



2-Mercapto-1-benzothiazole  
CAS Reg. No.: 149-30-4  
Molecular Weight: 167

## FUNCTION

Perkacit MBT is a moderately fast curing primary accelerator for natural and synthetic rubbers.

## MAJOR APPLICATIONS AND PROPERTIES

- In NR compounds, Perkacit MBT based vulcanization systems exhibit less reversion upon overcure than other systems.
- Its low activation energy makes compounds rather scorchy, particularly in furnace black reinforced compounds. Compound scorch behavior can be improved by replacing Perkacit MBT with Perkacit MBIS.
- Vulcanizates obtained with Perkacit MBT tend to have a relatively low modulus, but very good aging properties.
- To achieve a faster cure and a higher modulus, Perkacit MBT can be boosted by the use of secondary accelerators, such as Perkacit ZBEC, Perkacit ZDEC, Perkacit TBZTD, Perkacit TMDD or Perkacit DRG.
- For the vulcanization of EPDM or IIR rubbers, Perkacit MBT is a well established component of many existing vulcanization systems.
- Perkacit MBT also finds application in latex foam cure systems.
- The product is non-staining and non-discoloring.
- Perkacit MBT is regulated for use in articles in contact with food as specified under FDA 21 CFR 177.2600, 175.105, 176.300 and under BgVV XXI Categories 1-4 and "Sonderkategorie".

## COMPOUNDING INFORMATION

In NR compounds Perkacit MBT can be used as the sole accelerator at levels ranging from 1.0 to 1.5 phr. In combinations with other accelerators its typical usage level can vary between 0.5 and 1.5 phr. In SBR compounds Perkacit MBT is usually used from 1.5 to 3.0 phr either alone or in combination with other accelerators. In IIR or EPDM compounds levels up to 1.5 phr may be used in combinations with other accelerators, such as Perkacit TMDD, Perkacit ZBMC, Voccol ZBDP, and/or Antocure CBS. For latex and latex foam applications a 50 % aqueous dispersion should be used to establish, for instance, a typical SBR latex foam cure system with Perkacit MBT: 1.0 to 2.0 (dry) phr, Perkacit ZDEC: 1.5 phr, and sulfur 2 phr.

With SBR the use of bioassays is commonly regarded to enable us to quantify the impact of the effluent on the biota. In Aquatica, Pankowall MBI is the only assay that can be used to test a large number of organisms in a test chamber. InMCI and Pankowall P/C C<sub>1</sub> bioassays MBI is the only test that can be used to test the impact of effluents on the biota. InMCI bioassays can be used to test the impact of effluents on the biota. InMCI bioassays can be used to test the impact of effluents on the biota.

# HANDLING PRECAUTIONS

For detailed information on toxicological properties and handling precautions please refer to the current Safety Data Sheet. This information sheet can be requested from the nearest Flexsys office and should be consulted before handling this product.

## STORAGE RECOMMENDATIONS

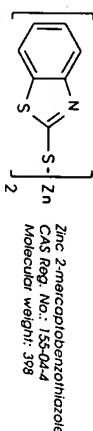
Store Perkocit MBIS in a cool, dry, well ventilated area, avoiding exposure of the packaged product to direct sunlight.

## PRODUCT INFORMATION

Perkocit MBIS Product form	pd powder	pd-d dust suppressed	
<b>PHYSICAL SPECIFICATIONS</b>			
Appearance	cream powder	cream powder	FR7,5
Assay (titration)	90.0	90.0	FR8,1
Free MBT (%) min.	1.0	1.0	FR9,22
Melting point initial (°C) min.	167	165	FR9,9
Melting point final (°C) min.	171-179	171-179	FR9,7
Heating loss (%) max.	0.5	0.5	FR9,7
Acidic residue on 150 µm sieve (%) max.	0.5	0.5	FR9,7
Residue on 63 µm sieve (%) max.	0.05	10-20	FR9,7
Residue on 3 µm sieve (%) max.	0.5	0.5	FR9,7
<b>TYPICAL PROPERTIES</b>			
Density at 20°C (kg/m³)	1540	1540	FR9,7
<b>PACKAGING</b>			
25 kg BGC	20 kg	20 kg	
1000 kg	1000 kg		

Perkocit MBIS is also available as 80% masterbatch.

# PERKOCIT ZMBI



## FUNCTION

Perkocit ZMBI's main function is as secondary accelerator in sulfur cured latex. In dry rubber applications, Perkocit ZMBI is a moderately fast curing primary accelerator.

## MAJOR APPLICATIONS AND PROPERTIES

- In latex vulcanization Perkocit ZMBI is used in combination with Perkocit ZBEC, Perkocit ZDMC or Perkocit ZDEC.
- By using Perkocit ZMBI, markedly higher moduli in latex films are obtained than with dithiocarbamates alone; furthermore a better compression set resistance in latex foam can be achieved, without increasing the cure time.
- Perkocit ZMBI does not destabilize latex formulations.
- In latex tread applications the low free MBT grade of Perkocit ZMBI (pd-5) gives reduced extraction of MBT during acid coagulation (acid bath pollution) and helps to stabilize the viscosity of latex compounds during storage.
- In dry rubber applications the performance of Perkocit ZMBI is almost similar to Perkocit MBT, but with a slight scorch improvement.
- Perkocit ZMBI is registered for use in articles in contact with food as specified under FDA 21 CFR 177.2600, 175.105, 178.3120 and under BGVV XXI, Categories 3-4.

## COMPOUNDING INFORMATION

Perkocit ZMBI is particularly recommended for use in combination with Perkocit ZDEC in latex compounds of all types. Various ratios can be used; for economic considerations it is desirable to have the proportion of Perkocit ZMBI in the mixture as high as possible without impairing the speed of cure. As a general guide, equal parts of Perkocit ZMBI and Perkocit ZDEC give good results. Good general purpose systems in dry phr are the following:

NR latex : sulfur : 1.0; Perkocit ZDEC : 0.5; Perkocit ZMBI : 0.5 phr  
SBR latex : sulfur : 2.0; Perkocit ZDEC : 1.0; Perkocit ZMBI : 1.0 phr

# HANDLING PRECAUTIONS

For detailed information on toxicological properties and handling precautions please refer to the current Safety Data Sheet. This information sheet can be requested from the nearest Flexsys office and should be consulted before handling this product.

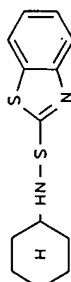
# STORAGE RECOMMENDATIONS

Store Perkacit ZMBT in a cool, dry, well ventilated area, avoiding exposure of the packaged product to direct sunlight.

# PRODUCT INFORMATION

Product form	Perkacit ZMBT	Perkacit ZMBT
Product form	powder	low free MBT powder
Appearance	white to slightly yellow powder	white to slightly yellow powder
Zinc content (%)	15.0-18.0	22.5-25.5
Free MBT (%)	14-18	0-2
Heat loss (%) max.	0.5	0.5
Residue on 150 µm sieve (%) max.	0.1	0.1
TYPICAL PROPERTIES		
Density at 20°C (kg/m³)	1.70	1.70
Bulk density (kg/m³)	470-510	300-340
Compacted bulk density (kg/m³)	480-520	370-410
PACKAGING	20kg	20kg
Test method	Test method PP7.5	Test method PP7.5
	IC6972	IC6972
	FA684	FA684
	FC977	FC977
	FF338	FF338

# SANTOCURE CBS



N-cyclohexyl-2-benzothiazylsulfonamide  
CAS Reg. No.: 95-33-0  
Molecular weight: 264

# FUNCTION

Santocure CBS is a primary amine based, general purpose primary accelerator combining a fast cure with good scorch safety and excellent modulus development.

# MAJOR APPLICATIONS AND PROPERTIES

- In natural and synthetic rubber like compounds, Santocure CBS is normally used alone or with small quantities of secondary accelerators in combination with sulfur.
- In industrial rubber products, Santocure CBS can be used with secondary accelerators, such as Perkacit TMBD, to replace MBTS/DBS systems.
- Santocure CBS may also be used in EPDM and NBR compounding as the primary accelerator, giving good scorch delay and fast cure rates.
- Vulcanizates obtained with Santocure CBS show excellent physical properties.
- Santocure CBS can be used as the basis for efficient vulcanization (EV) systems in combination with high levels of secondary accelerators, such as the thiazoles, to obtain improved heat-aging properties.
- Santocure CBS can (in combination with Santogard PV) be used as an alternative for MBTS in applications where the presence of N-nitrosamines is of concern, and where equal scorch safety and faster cure rate are required.
- Santocure CBS does not form carcinogenic N-nitrosamines.
- At high concentrations, Santocure CBS will cause slight discoloration in white or light colored compounds, but it is non-staining.
- Santocure CBS is regulated for use in articles in contact with food as specified under FDA 21 CFR 177.2600 and under BgVV XXI, Category 4.

# COMPOUNDING INFORMATION

In NR based compounds, loadings of Santocure CBS usually range from 0.5 to 1.5 phr, with the higher levels being associated with reduced levels of sulfur in synthetic rubbers, dosages of Santocure CBS are usually higher than those in NR, and for SBR usually lie between 1.0 to 2.5 phr with sulfur levels in the range of 2 to 1 phr respectively. Increasing the Santocure CBS level whilst reducing the sulfur loading increases the cure efficiency, resulting in improved scorch resistance, faster cure rate, and improved reversion and aging resistance. Fully efficient cure (EV) gives even better reversion and aging resistance. However, for EV cured NR compounds, flex-cracking and other dynamic properties will be lower.

Improved aging and flex resistance, with only little effect on initial flex-cracking resistance in NR, can be accomplished by direct replacement of sulfur by Sulfocure DTCB. Maximum aging resistance can be obtained by omission of sulfur and addition of Perkacil TMD as a means of obtaining the required modulus. Santicure CBS based cure systems can be boosted by accelerators such as the thurams, dithiocarbamides and DPG.

**HANDLING PRECAUTIONS**

For detailed information on toxicological properties and handling precautions please refer to the current Society Data Sheet. This information sheet can be requested from the nearest Flexsys office and should be consulted before handling this product.

**STORAGE RECOMMENDATIONS**

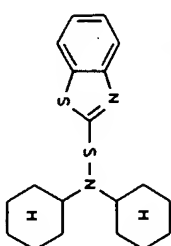
Store Santicure CBS in single stocked pallets in a cool, dry, well ventilated area, avoiding exposure of the packaged product to direct sunlight. Double stocking of palletized material can result in unusually compacted product or broken granules. High humidity and/or temperature can cause degradation that may result in reduced scorch time. Material suspected of degradation can be evaluated in a test compound before use. Do not store this product near Crytox as the odorous vapours characteristically emitted from this material can cause Crytox to revert to 'Rubber Macker' sulfur.

**PRODUCT INFORMATION**

Santicure CBS	pd-d	pd-d4	gp-3mm	test method
Product form	powder	extruded powder	granules	
Appearance	off white to tan powder	off white to tan powder	off white to tan granules	test method
Assay (extruded)	97	94.0	97	FTIR
Moisture part, free	100-105	98-105	100-105	test method
Moisture	0.4	0.5	0.4	test method
Acid	0.3	0.3	0.3	test method
Residue in methanol	0.5	0.5	0.5	test method
(on binder sheet test)				
Active	0.1	0.1	-	test method
Residue on 150 mesh	0.1	0.1	-	test method
Residue on 60 mesh	0.5	0.5	-	test method
INTEGRITY	1200	1200	1200	test method
Density at 25 °C	(g/cm <sup>3</sup> )			
PACKAGING				
Bag (40kg)	20kg	20kg	20kg	
Bag (100kg)	25kg	-	25kg	
IBC (1000kg)	-	-	1000kg	
IBC (1000kg)	-	-	4500kg	

Santicure CBS is also available as 80 % masterbatch.

**SANTICURE DCBS**



N,N-Dicyclohexyl 2-benzothiazolesulfenamide  
CAS Reg. No. 4773-32-2  
Molecular weight 347

**FUNCTION**

Santicure DCBS is a slow curing delayed action accelerator

**MAJOR APPLICATIONS AND PROPERTIES**

- Santicure DCBS is particularly suitable (as sole accelerator) for rubber compounds where direct bonding to brass surfaces or brass coated steel wires is required (e.g. tires and conveyor belts)
- Santicure DCBS has the best scorch resistance of the whole range of sulfenamide accelerators. It produces a markedly slower cure and lower modulus than Santicure CBS, TBBS or MBS
- The slower cure rate is useful when curing thick extrusions (e.g. tread) or other thick articles.
- Santicure DCBS provides excellent compound (storage and processing) stability, making it ideal for compounds with high loadings of furnace blacks.
- At high concentrations, Santicure DCBS will cause slight discoloration in white or light colored compounds, but it is non-staining
- Santicure DCBS is regulated for use in articles in contact with food as specified under BGV XXI, Category 4. Santicure DCBS is not regulated for use in FDA food contact applications.

**COMPOUNDING INFORMATION**

In NR compounds, loadings of Santicure DCBS are usually in the range of 0.7 to 2.0 phr with sulfur levels of 2.5 to 1.5 phr. For steel cord reinforced skin compounds sulfur levels of around 4.0 phr are commonly used. In SBR loadings vary from 1.2 to 3.0 phr, with sulfur levels ranging from 2.2 to 1.0 phr.

Increasing the accelerator/sulfur ratio, enhances the cure efficiency, at the same time improving processing safety, reversion and aging resistance. The use of activators is not recommended in combination with Santicure DCBS where a reduction in scorch delay can not be tolerated. Fine tuning

of the cure curve can be accomplished by blending Santocure DCBS with other sulfenamides.

#### HANDLING PRECAUTIONS

For detailed information on toxicological properties and handling precautions, please refer to the current Safety Data Sheet. This information sheet can be requested from the nearest Flexsys office and should be consulted before handling this product.

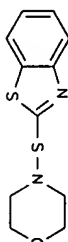
#### STORAGE RECOMMENDATIONS

Store Santocure DCBS in single stacked pellets in a cool, dry, well ventilated area, avoiding exposure of the packaged product to direct sunlight. Double stocking of pelletized material can result in unusually compacted product or broken granules. High humidity and/or temperature can cause degradation that may result in reduced scorch time. Material suspected of degradation can be evaluated in a test compound before use. Do not store this product near Cystex as the amine vapors characteristically emitted from this material can cause Cystex to revert to "Rubber Mcker's" sulfur.

#### PRODUCT INFORMATION

Santocure DCBS Product form	gfs-2mm 2mm granules	Test Method
Appearance	off white to tan granules	FF97.5
Assay (titration)	96.0	FA90.4
Melting point, (mnd)	100 - 105	FF93.9
Moisture	0.4	FAMP90.1
Ash	0.3	FG90.9
Insoluble in cyclohexane	0.5	FG90.11
TYPICAL PROPERTIES Density at 21 °C (kg/m <sup>3</sup> )	1230	
PACKAGING Bag	20 kg	
FIBC	900 kg	

#### SANTOCURE MBS



2,4-Morpholinobenzothiazole  
CAS Reg. No.: 102 77 2  
Molecular weight 252

#### FUNCTION

Santocure MBS is a general purpose primary accelerator giving the highest level of processing safety of oil (moderately) fast curing sulfenamide accelerators, combined with a moderately fast cure rate and good modulus development.

#### MAJOR APPLICATIONS AND PROPERTIES

- The product can be used as sole accelerator or in combination with low levels of secondary accelerators in NR or synthetic rubber compounds where extended scorch times are required. Typical examples are thick tire treads and extrusions, compounds with high loadings of furnace blocks and compounds which are stored, uncured, for long periods such as comeback.
- The long scorch delay of Santocure MBS is also advantageous in injection molding, allowing the safe use of high injection temperatures
- Santocure MBS is also an excellent accelerator for EPDM cure systems where a high degree of processing safety needs to be combined with a fast cure.
- Its general characteristics closely resemble Santocure CBS, but Santocure MBS gives better scorch resistance and cures slightly slower
- It should be noted that in the application of Santocure MBS N-nitrosomorpholine can be formed by the reaction of morpholine a decomposition product, with nitrosating agents (nitrogen oxides)
- At high concentrations, Santocure MBS will cause slight discoloration in white or light colored compounds, but it is non-staining
- Santocure MBS is required for use in articles in contact with food as specified under FDA 21 CFR 177.2600 and under BgVV XXI Category 4

#### COMPOUNDING INFORMATION

In NR the levels of Santocure MBS range from 0.5 to 1.5 phr with the higher levels being associated with reduced levels of sulfur. Because Santocure TBBS already gives adequate processing safety Santocure MBS is less frequently used in SBR based compounds. In synthetic rubber compounds where long scorch delay is required Santocure MBS can be used at similar levels as Santocure TBBS. In SBR Santocure MBS levels usually vary between 1.0 and 2.5 phr with sulfur levels of 2 to 1 phr respectively.

Increasing the accelerator/sulfur-ratio in general increases the cure efficiency, resulting in improved scorch resistance, faster cure rate, and improved reversion and aging resistance. However, after fully efficient cure (EV) of NR compounds, flex-cracking and dynamic properties will be lower. Improved aging and flex resistance, with only little effect on initial flex-cracking resistance in NR, can be accomplished by direct replacement of sulfur by Sulfoson DTDM. Maximum aging resistance can be obtained by omission of sulfur and addition of Perkacit TM1D as a means of obtaining the required modulus. Santocure MBS based cure systems can be boosted by accelerators such as thiazoles, dithiocarbamates and DPG.

#### HANDLING PRECAUTIONS

For detailed information on toxicological properties and handling precautions please refer to the current Safety Data Sheet. This information sheet can be requested from the nearest Flexsys office and should be consulted before handling this product.

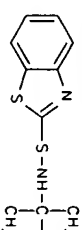
#### STORAGE RECOMMENDATIONS

Store Santocure MBS in single stocked pallets in a cool, dry, well ventilated area, avoiding exposure of the packaged product to direct sunlight. Double stocking of palletized material can result in unusually compacted product or broken granules. High humidity and/or temperature can cause degradation that may result in reduced scorch time. Material suspected of degradation can be evaluated in a test compound before use. Do not store this product near Cystex as the amine vapors characteristically emitted from this material can cause Cystex to revert to "Rubber Mackerel" sulfur.

#### PRODUCT INFORMATION

Product form	2mm granules	Test method
Appearance	off white to tan granules	FF97.5
Assay (titration)	(%) min. 95.0	FAC90.4
Melting point, final	(°C) 82-88	FF83.9
Moisture	(%) max. 0.4	FAMP90.1
Ash	(%) max. 0.3	FC90.9
Insoluble in methanol (on binder-free basis)	(%) max. 0.5	FC90.7
Density at 20 °C	(kg/m <sup>3</sup> ) 1300	
PACKAGING		
Bag	20 kg	
FIBC	900 kg	

#### SANTOCURE 1B85



N-tert-butyl-2-benzothiazylsulfenamide  
CAS Reg. No. 95-31-8  
Molecular weight: 238

#### FUNCTION

Santocure 1B85 is a primary amine based, general purpose primary accelerator combining a fast cure with good scorch safety and excellent modulus development.

#### MAJOR APPLICATIONS AND PROPERTIES

- In natural and synthetic rubber the compounds Santocure 1B85 is normally used alone or with small quantities of secondary accelerators in combination with sulfur.
- Santocure 1B85 is also used in industrial rubber products with higher levels of secondary accelerators such as Perkacit TM1D to obtain faster vulcanization cycles and improved aging resistance.
- Santocure 1B85 may also be used in EPDM and NBR compounding as the primary accelerator, giving good scorch delay and fast cure rates.
- In comparison to Santocure C85 it displays a slightly longer scorch delay and is slightly more active. In NR, SBR, BR and blends, Santocure 1B85 when used at a 10% lower level, will give equal modulus to Santocure C85 and MBS.

- Santocure 1B85 can (in combination with Santogard PV) be used as an alternative for MBS in applications where the presence of N-nitrosamines is of concern and where equal scorch safety and faster cure rate are required. Santocure 1B85 does not form carcinogenic N-nitrosamines.

- At high concentrations, Santocure 1B85 will cause slight discoloration in white or light colored compounds, but it is non-staining.

- Santocure 1B85 is regulated for use in articles in contact with food as specified under FDA 21 CFR 177.2600 and under BgVV XXI, Category 4

#### COMPOUNDING INFORMATION

In NR based compounds, loadings of Santocure 1B85 usually range from 0.5 to 1.5 phr, with the higher levels being associated with reduced levels of sulfur in synthetic rubbers. Dosages of Santocure 1B85 are usually higher than those in NR, and for SBR usually lie between 1.0 to 2.5 phr with sulfur levels 1 phr range of 2 to 1 phr respectively.

Increasing the Santocure 1B85 level whilst reducing the sulfur loading increases the cure efficiency, resulting in improved scorch resistance, faster cure rate, and improved reversion and aging resistance. Fully efficient cure (EV) gives even better reversion and aging resistance. However, for EV cured NR compounds, flex-cracking and other dynamic properties will be lower. Improved aging and flex resistance, with only little effect on initial flex-

cracking resistance in NR can be accomplished by direct replacement of sulfur by Sulfocure TBSI. Maximum aging resistance can be obtained by omission of sulfur and addition of Perkacil TMTD as a means of obtaining the required modulus.

Santocure TBSI based cure systems can be boosted by accelerators such as thiurams, dithiocarbamates and DPG.

#### HANDLING PRECAUTIONS

For detailed information on toxicological properties and handling precautions please refer to the current Safety Data Sheet. This information sheet can be requested from the nearest Hexys office and should be consulted before handling this product.

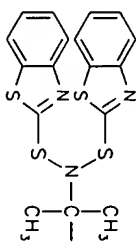
#### STORAGE RECOMMENDATIONS

Store Santocure TBSI in single stocked pallets in a cool, dry, well ventilated area, avoiding exposure of the packaged product to direct sunlight. Double stocking of palletized material can result in unusually compacted product or broken granules. High humidity and/or temperature can cause degradation that may result in reduced scorch time. Material suspected of degradation can be evaluated in a test compound before use. Do not store this product near Cystex as the amine vapors characteristically emitted from this material can cause Cystex to revert to "Rubber Maker's" sulfur.

#### PRODUCT INFORMATION

Santocure TBSI Product form	pel-d dust suppressed powder	gr-2mm 2mm granules	Test method FT/7.5
APPEARANCE	off white to tan powder	off white to tan granules	
ASSAY (titration) (%) min.	95.0	95.0	FA-204
Melting point, initial (°C) min.	105	105	FR33.9
Melting point, final (°C)	107-112	107-112	FR33.9
Moisture (%) max.	0.4	0.4	FA-901
Ash (%) max.	0.4	0.4	FR-909
Insoluble in methanol (%) max.	0.5	0.5	FR-907
(on binder-free basis)			
Residue on 150µm sieve (%) max.	0.1	-	FR33.8
Residue on 63µm sieve (%) max.	0.5	-	FR33.8
TYPICAL PROPERTIES (g/cm <sup>3</sup> )	1.280	1.280	
Density at 25°C			
PACKAGING			
Bag (Antiwrap)	20 kg	20 kg	
Bag (Net)	25 kg	25 kg	
IBC (Antiwrap)	425 kg	900 kg	
IBC (Net)		425/830 kg	

#### SANTOCURE TBSI



N-tert-butyl-2-benzothiazolylsulfenamide  
CAS Reg. No.: 3741-80-8  
Molecular weight: 404

#### FUNCTION

Santocure TBSI is a primary amine based accelerator giving long scorch times and slow cure rates similar to sulfenamide accelerators based on secondary amines.

#### MAJOR APPLICATIONS AND PROPERTIES

- Santocure TBSI is a delayed action, slow curing, modulus efficient accelerator, which makes it ideal for:
  - Thick articles requiring a balanced cure throughout the cross section
  - Optimizing adhesion between rubber and brass coated steel cord.
- Santocure TBSI provides improved reversion resistance as compared to sulfenamide accelerators both during extended cure times at elevated temperatures and during product service life.
- Santocure TBSI will also give lower heat generation during dynamic mechanical service conditions.
- Due to its unique chemical structure Santocure TBSI exhibits outstanding storage stability under hot and humid storage conditions.
- At higher concentrations, Santocure TBSI will cause slight discoloration in white or light colored compounds, but it is non-staining.
- Santocure TBSI is regulated for use in articles in contact with food as specified under BGV XXI, Category 4. Santocure TBSI is not regulated for use in FDA food contact applications.

#### COMPOUNDING INFORMATION

Santocure TBSI is normally used at levels similar to those used with sulfenamide accelerators for conventional, semi-efficient or efficient vulcanization systems.

Compared to the various sulfenamide accelerators in NR, Santocure TBSI provides:

- Moderate scorch delay similar to Santocure TMS.

# **RUBBER CHEMICALS EQUIVALENTS LIST**

**Monsanto**

260 Springside Drive  
Akron, Ohio 44313  
Phone: (216) ~~867-5460~~ 666 4111

Exhibit B

This booklet is intended as a guide to chemical equivalents and is a compilation of several available commercial sources as well as Monsanto files. It is as accurate as we can reasonably be expected to make it; however, as Monsanto has no control over others manufacturing processes or the names assigned to various chemicals, the booklet cannot be considered a final authority but rather the user should consult the supplier of the chemical in question. Also, by necessity, the book contains several materials no longer commercially available; therefore, the presence of a chemical in the booklet does not necessarily mean that one can purchase the material.

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*Issued: January, 1978*

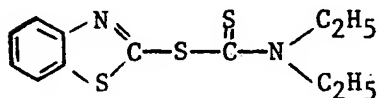
# CONTENTS

## Index to Materials

	Page No.
Aldehyde Amines.....	1 - 3
Amines .....	4 - 5
Dithiocarbamates.....	6 - 12
Dithiophosphates.....	13
Guanidines.....	14
Sulfenamides .....	15 - 17
Thioureas.....	18 - 20
Thiurams .....	21 - 23
Thiazoles .....	24 - 25
Ureas .....	26
Xanthates.....	27
Miscellaneous Accelerators .....	28 - 30
Vulcanizing Agents .....	31 - 32
Retarders .....	33 - 35
Promoters .....	36
Amino Phenols .....	37 - 38
Hindered Bisphenols.....	39 - 42
Hindered Phenols .....	43 - 47
Hindered Thiobisphenols.....	48 - 49
Hydroquinones .....	50 - 51
Phosphites .....	52
Miscellaneous Non Staining Antioxidants .....	53 - 55
Diphenyl Amines .....	56 - 57
Naphthyl Amines .....	58
Alkyl Diamines .....	59
Phenylene Diamines.....	60
Blended Amines .....	61 - 64
Carbonyl-Amine Condensation Products .....	65 - 67
Quinolines.....	68
Miscellaneous Staining Antioxidants .....	69
Dialkyl PPD.....	70 - 71
Alkyl-Aryl PPD .....	72 - 73
Di Aryl PPD .....	74
PPD Blends .....	75 - 76
Miscellaneous Antidegradants.....	77 - 78

# THIAZOLES

## 2-Benzothiazyl-N,N-diethylthiocarbamyl sulfide



### Tradename

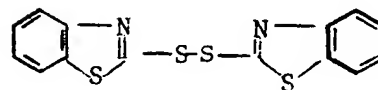
Ethylac

### Supplier

Pennwalt

*Physical Form:* Yellow solid  
mp 69° C

## Benzothiazyl disulfide



### Tradename

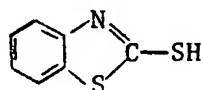
Thiofide®  
Akrochem MBTS  
MBTS  
Vulkacit DM/C  
MBTS  
MBTS  
Altax  
Royal MBTS  
Pennac MBTS

### Supplier

MONSANTO  
Akron Chemical  
American Cyanamid  
Bayer (Mobay)  
Dupont  
Uniroyal  
Vanderbilt  
H. M. Royal  
Pennwalt

*Physical Form:* Cream solid  
mp 167° C

## 2-Mercaptobenzothiazole



### Tradename

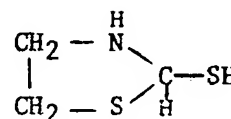
Thiotax®  
Akrochem MBT  
MBT  
Vulkacit Mercapto  
MBT  
MBT  
Captax  
Royal MBT  
Rotax (Specially  
Purified)  
Pennac MBT

### Supplier

MONSANTO  
Akron Chemical  
American Cyanamid  
Bayer (Mobay)  
Dupont  
Uniroyal  
Vanderbilt  
H. M. Royal  
Vanderbilt  
Pennwalt

*Physical Form:* Cream-to-light yellow solid  
mp 170-175° C

## 2-Mercaptothiazoline



### Tradename

2-MT

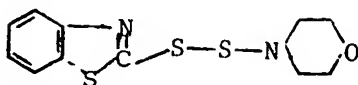
### Supplier

American Cyanamid

*Physical Form:* Cream solid  
mp 101° C

# THIAZOLES

## 2-(m rph lin dithi )-b nz thiaz le



Tradename

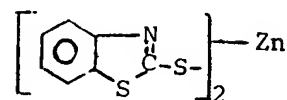
Morfax

Supplier

Vanderbilt

*Physical Form:* Cream powder  
mp 125-135° C

## Zinc salt f 2-m rcapt b nzothiaz l



Tradename

ZMBT  
Vulkacit ZM  
Zenite°  
Pennac ZT  
O-x-a-f  
Zetax  
Bantex®  
Zenite Special

Supplier

American Cyanamid  
Bayer (Mobay)  
Dupont  
Pennwalt  
Uniroyal  
Vanderbilt  
MONSANTO  
Dupont

*Physical Form:* Pale yellow solid  
mp 250° C

\*Bantex not normally distributed in the US

° *Zenite contains wax*

## A Copper Compound

Tradename

Cupsac

Supplier

American Cyanamid

*Physical Form:* Pale yellow solid  
mp 250° C